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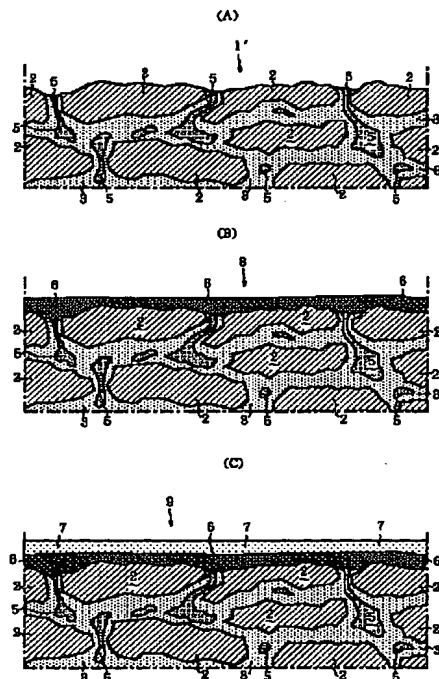
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(54) 【発明の名称】 希土類ボンド磁石とその製造方法

(57) 【要約】

【課題】 錆びにくく且つ熱変化による割れや欠けを生じにくい強固な希土類ボンド磁石と、その製造方法を提供する。

【解決手段】 Nd-Fe-B系合金からなる希土類磁石粉末2をバインダのエポキシ系樹脂3で結合した磁石素材1に対し、その表層面に位置する希土類磁石粉末2の表面上に直にNiメッキ層6を形成した希土類ボンド磁石8。また、このボンド磁石8のNiメッキ層6の表面上に更にエポキシ系樹脂の樹脂被覆層7を形成した希土類ボンド磁石9も含む。更に、アクリル樹脂5を上記磁石素材1中に含浸させ、且つ磁石粉末2の外表面を覆うエポキシ系樹脂3等をドライエッチングにより除去し、得られた磁石素材1'の露出した磁石粉末2の表面上に直接Niメッキを施し、上記Niメッキ層6を形成する希土類ボンド磁石8や、これに更に樹脂被覆層7を形成した希土類ボンド磁石9の製造方法も含まれる。



【特許請求の範囲】

【請求項 1】希土類磁石粉末を樹脂バインダにより結合した希土類ボンド磁石であって、その表層面に位置する上記磁石粉末の表面上に直に金属メッキ層が形成されている、ことを特徴とする希土類ボンド磁石。

【請求項 2】希土類磁石粉末を樹脂バインダにより結合した希土類ボンド磁石であって、その表層面に位置する上記磁石粉末の表面上に直に金属メッキ層が形成されると共に、該金属メッキ層の表面上に更に樹脂被覆層が形成されている、ことを特徴とする希土類ボンド磁石。

【請求項 3】前記希土類磁石粉末が超急冷法による Nd - Fe - B 系磁石合金粉末であり、前記樹脂バインダがエポキシ系樹脂である、ことを特徴とする請求項 1 又は 2 に記載の希土類ボンド磁石。

【請求項 4】前記金属メッキ層が Ni 又は Cu 或いはこれらの何れかをベースとする合金からなる、ことを特徴とする請求項 1 乃至 3 の何れかに記載の希土類ボンド磁石。

【請求項 5】前記樹脂バインダ内にアクリル系等の嫌気性樹脂が含まれている、ことを特徴とする請求項 1 乃至 4 の何れかに記載の希土類ボンド磁石。

【請求項 6】希土類磁石粉末と樹脂バインダを混合し所定形状の希土類磁石素材に成形する工程と、この磁石素材に嫌気性樹脂を含浸する工程と、その後この磁石素材の表層面を覆う樹脂バインダ等の有機物を除去するクリーニング工程と、該磁石素材の表層面に位置する上記磁石粉末の表面上に直に金属メッキ層を形成する工程とを含む、ことを特徴とする希土類ボンド磁石の製造方法。

【請求項 7】請求項 6 における前記各工程を含むと共に、前記金属メッキ層を形成する工程の後に、更に該金属メッキ層の表面上に樹脂被覆層を形成する工程を有する、ことを特徴とする希土類ボンド磁石の製造方法。

【請求項 8】前記嫌気性樹脂がアクリル系等の樹脂である、ことを特徴とする請求項 6 又は 7 に記載の希土類ボンド磁石の製造方法。

【請求項 9】前記磁石素材の表層を覆う樹脂バインダ等の有機物を除去するクリーニング工程が、プラズマエッチング、反応性イオンエッチング、イオンビームエッチング、反応性イオンビームエッチング、又は、反応性ガスエッチング等のドライエッチングにより行われる、ことを特徴とする請求項 6 乃至 8 の何れかに記載の希土類ボンド磁石の製造方法。

【請求項 10】前記金属メッキ層を形成する工程が、ワット浴又はスルファミン酸浴を用いて行う Ni メッキである、ことを特徴とする請求項 6 乃至 9 の何れかに記載の希土類ボンド磁石の製造方法。

【発明の詳細な説明】

【 0 0 0 1 】

【発明の属する技術分野】本発明は、モータ用、或いは磁気センサ用等の広汎な用途において使用される希土類ボンド磁石とその製造方法に関する。

【 0 0 0 2 】

【従来の技術】一般に、希土類ボンド磁石は、希土類磁石粉末に対し数 wt % ずつの樹脂バインダと成形助剤等を混合した後、所定の形状にプレス等によって成形し、更に加熱して上記樹脂バインダを硬化させることにより製造されている。また、上記希土類磁石粉末は酸化して発錆し易い性質を有し、且つ樹脂バインダも含めて脆いため、組立時等や熱変化によって割れや欠けを生じ易い。これらを防ぐため、磁石の表面に電着塗装等による樹脂層が更に被覆されている。

【 0 0 0 3 】ところで、上記の希土類ボンド磁石を組み込んだモータ等が、海岸付近の塩水を含む雰囲気や著しい温度差の環境において用いられると、希土類ボンド磁石の表面に錆や割れ等を生じることがある。このため、電着塗装等による樹脂被覆に替えて、ボンド磁石の表面に緻密な金属メッキ層を形成することも考えられる。しかしながら、熱硬化させた希土類ボンド磁石の表面には、バインダとして用いた樹脂皮膜が形成されているため、この樹脂皮膜がこの金属メッキを施す際に電気不導体として作用したり、膜形成のブロック作用によってピンホールを形成するという問題がある。

【 0 0 0 4 】更に、熱硬化させた希土類ボンド磁石内の磁石粉末の間や樹脂バインダ中には、空孔が形成される場合がある。この空孔内には、例えばボンド磁石を洗浄する際や上記金属メッキのためメッキ浴中に浸漬すると、水分やメッキ液が残留する。この残留水分等は、表面に樹脂被覆層又は金属メッキを形成した希土類ボンド磁石が長年に涉って使用されると、何らかの機会に外気と連通して周囲の磁石粉末を酸化させ発錆を招くという問題があった。

【 0 0 0 5 】

【発明が解決すべき課題】本発明は、以上における従来の技術の問題点を解決し、錆にくく且つ熱変化による割れや欠けを生じにくい高強度の希土類ボンド磁石と、これを製造するのに適した希土類ボンド磁石の製造方法を提供することを課題とする。

【 0 0 0 6 】

【課題を解決するための手段】本発明は、希土類ボンド磁石の表層面における磁石粉末の表面上に直に金属メッキ層を形成することに着想して成されたものである。即ち、本発明の希土類ボンド磁石は、希土類磁石粉末を樹脂バインダにより結合した希土類ボンド磁石であって、その表層面に位置する上記磁石粉末の表面上に直に金属メッキ層が形成されている、ことを特徴とする。これによれば、緻密で強固な金属メッキ層が表面に形成された希土類ボンド磁石となるため、錆にくい優れた耐食性と熱変化による割れや欠けを生じにくい強度を有し、長期

的に安定した磁気特性を発揮せしめることができる。

【0007】尚、本発明においては、着磁される前のものを含めて磁石と称する。また、本発明のもう一つの希土類ボンド磁石は、希土類磁石粉末を樹脂バインダにより結合した希土類ボンド磁石であって、その表層面に位置する上記磁石粉末の表面上に直に金属メッキ層が形成されると共に、該金属メッキ層の表面上に更に樹脂被覆層が形成されている、ことを特徴とする。これによれば、上記に加えて更に一層耐食性に優れた希土類ボンド磁石を提供することができる。

【0008】更に、前記希土類磁石粉末が超急冷法により得られるNd-Fe-B系磁石合金粉末であり、前記樹脂バインダがエポキシ系樹脂である、希土類ボンド磁石も含む。これにより、高磁気エネルギー積等の磁気特性と優れた耐食性及び高強度を保有させることができる。尚、Ndの置換元素としては、Pr, La, Ce, Sm, Mm等の希土類元素の1種又は2種以上が用いられ、またFeの置換元素としては、Co, Ni, Mn, Cu等が用いられ、更にBの置換元素としては、Si, P, C, N等が適宜用いられる。

【0009】また、前記金属メッキ層がNi又はCu或いはこれらの何れかをベースとする合金からなる、希土類ボンド磁石も含まれる。これによれば、緻密で強固なNi等の金属メッキ層によって表面が被覆されているため、高強度で且つ防錆性に優れた安定した希土類ボンド磁石となる。更にまた、前記樹脂バインダ内にアクリル系等の嫌気性樹脂が含まれている希土類ボンド磁石も含まれる。これにより、内部の少なくとも表層部に空孔がなく且つ表面にNi等の金属メッキ層を強固に被覆した希土類ボンド磁石となる。

【00010】一方、本発明の希土類ボンド磁石の製造方法は、希土類磁石粉末と樹脂バインダを混合し所定形状の希土類磁石素材に成形する工程と、この磁石素材に嫌気性樹脂を含浸する工程と、その後この磁石素材の表層面を覆う樹脂バインダ等の有機物を除去するクリーニング工程と、該磁石素材の表層面に位置する上記磁石粉末の表面上に直に金属メッキ層を形成する工程とを含む、ことを特徴とする。これにより、少なくとも表層部を空孔のない緻密な組織とし、且つ表面に磁石粉末と直接結合した金属メッキ層を有する希土類ボンド磁石を確実に提供することができる。尚、上記の嫌気性樹脂を含浸する工程は、減圧下で行うか、或いは、減圧した後で加圧することによって行うことが望ましい。

【00011】また、前記製造方法における前記各工程を含むと共に、前記金属メッキ層を形成する工程の後に、更に該金属メッキ層の表面上に樹脂被覆層を形成する工程を有する、希土類ボンド磁石の製造方法も含まれる。これにより、上記に加えて一層耐食性に優れた希土類ボンド磁石を提供できる。更に、前記嫌気性樹脂がアクリル系等の樹脂である、希土類ボンド磁石の製造方法も含

む。これにより、内部の空孔を埋めると共に、表層面の磁石粉末の表面を樹脂分のない状態として強固な金属メッキ層を形成することができる。

【0012】また、前記磁石素材の表層を覆う樹脂バインダ等の有機物を除去するクリーニング工程が、プラズマエッチング、反応性イオンエッチング、イオンビームエッチング、反応性イオンビームエッチング、又は、反応性ガスエッチング等のドライエッチングにより行われる、希土類ボンド磁石の製造方法も含まれる。これによれば、表層面の磁石粉末の表面を確実に露出させ得るので、ボンド磁石の表面に確実に金属メッキ層を形成させることができる。尚、上記クリーニング工程には、上記の他にオゾンクリーニング、紫外線クリーニング、コロナ放電クリーニング等も含まれる。加えて前記金属メッキ層を形成する工程が、ワット浴又はスルファミン酸浴を用いて行うNiメッキである、希土類ボンド磁石の製造方法も含まれる。これにより、ボンド磁石の表面に健全なNiメッキ層を形成することができる。

【0013】

【発明の実施の形態】以下において本発明の実施に好適な形態を図面と共に説明する。図1は本発明の希土類ボンド磁石の製造方法のフローチャートを示す。先ず、超急冷法によりNd, Fe, Bの組成を有する扁平な希土類磁石粉末を製造する。この磁石粉末は、略長さ100~200 μ m、厚さ10~数10 μ mで、アスペクト比(長さ又は幅と厚さとの比)が5~10の範囲内のものである。この希土類磁石粉末:10重量部に対し、エポキシ系樹脂:10重量部と、成形助剤としてのステアリン酸亜鉛:2重量部を配合し、図示しないダイとポンチによるプレスを用いて、外径20mm、内径18mm、高さ7mmのリング形状に成形(S1)する。このリング状成形体を約140℃に加熱して、バインダたる上記エポキシ系樹脂を硬化(S2)させると、図2(A)に示す希土類磁石素材1となる。

【0014】次に、この希土類磁石素材1をバレルに入れ表面を研磨し成形時のバリ等を除去し、更に純水中に浸漬し超音波を与えて磁石素材1の表面を洗浄(S3)する。更に、洗浄後の希土類磁石素材1に対し、嫌気性アクリル樹脂の含浸(S4)を減圧下等で行う。上記磁石素材1は、図3(A)に模式的に示すように、扁平な多数の希土類磁石粉末2がエポキシ系樹脂3によって結合されているが、該樹脂3中や磁石粉末2、2間には空孔4が多数ランダムに存在するポーラスな組織になっている。また、一部の空孔4は外部とも連通している。この空孔4を埋めて緻密な組織にすることが、本含浸工程(S4)の目的である。図2(B)に示すように、压力容器11からなる含浸処理装置10内に予めアクリル等の嫌気性の樹脂液12を入れておく。先ず、複数の磁石素材1を入れたカゴ14を上記樹脂液12中に浸漬する。容器11の左上の排気管15からポンプ16により、容器11内

のエアを排出して容器11内を略真空近くにまで減圧する(S4a)。この際、容器11の右上の給気管17はその弁18により閉じておく。この結果、容器11内の圧力は数Torr〜数10Torr程度まで減圧されるため、上記樹脂液12は磁石素材1中の各空孔4内に強制的に含浸する。

【0015】所定時間が経過して磁石素材1中の各空孔4内に樹脂液12が含浸(S4a)された後、図2(C)に示すように、上記排気管15のポンプ16を停止し且つ図示しない弁により排気管15を閉じる。同時に、上記弁18を開き給気管17を通じてエアを容器11内に強制的に入れて数気圧程度に容器11内を加圧(S4b)する。これによって、磁石素材1中の各空孔4内に上記樹脂液12を十二分に含浸させることができる。次に、磁石素材1を取り出し、純水中に浸漬し超音波を与えて磁石素材1の表面を洗浄(S5)し、磁石素材1の表面に付着した嫌気性の樹脂12を除去する。この際、上記樹脂12は嫌気性のため容易に除去される。更に、所定温度に加熱して空孔4内の嫌気性の樹脂12を硬化(S6)させる。その結果、図3(B)に示すように、上記樹脂12は各空孔4の位置において硬化したアクリル系樹脂5になると共に、磁石素材1内の組織を緻密な状態にする。尚、上記樹脂12(5)は、図3(B)に示すように、磁石素材1の表層面には残っていない。

【0016】次いで、この磁石素材1に対し、ドライエッチングを施して、その表層面を覆うエポキシ系樹脂3等を除去(S7)する。上記ドライエッチングとしてプラズマエッチングを用いる。このプラズマエッチングは、数Torr以下の減圧状態において2枚の電極間で酸素のプラズマを均一に発生し、このプラズマ中に磁石素材1を置き、その表層面を覆うエポキシ系樹脂3を主とする有機物を灰化するものである。その結果、図4(A)に示すように、表層面に位置する各磁石粉末2の外側面が露出する磁石素材1'が得られる。この際、磁石素材1'の表層面には前記アクリル系樹脂5が覆っていないため、該素材1'の導電性が良好となる。

【0017】更に、この磁石素材1'に対して金属(Ni)メッキ(S8)を施す。このNiメッキは、例えばワット浴中にNiを陽極、磁石素材1'を陰極として浸漬し、両電極間に電圧を加える。そして、可溶性陽極のNiを溶解し金属イオンとして浴中に入れ、且つ陰極側の磁石素材1'の表面に析出させるものである。上記ワット浴には、例えば硫酸ニッケル:280g/リットル、塩化ニッケル:20g/リットル、ホウ酸:20g/リットル、光沢剤:少量を用い、且つ浴温:55℃、浴pH:5.6、電圧:7V、処理時間:10分のメッキ条件の電解Niメッキを行う。

【0018】このNiメッキに際し、磁石素材1'の表層面に位置する各磁石粉末2の露出する外側面が陰極として作用する。このため、図4(B)に示すように、緻密

で強固なNiメッキ層6を被覆した希土類ボンド磁石8を得ることができる。また、前記空孔4はアクリル系樹脂5によって埋められているため、上記メッキ液がボンド磁石9の内部に進入することもない。従って、このボンド磁石8のままでも適宜着磁することで、耐食性に優れた希土類ボンド磁石として使用できる。尚、係るNiメッキ工程をメッキ条件を変えて2段階に分け、初め半光沢Niメッキ層を形成し、更にその上面に光沢Niメッキ層を形成することもできる。また、上記Niメッキされた後において、ボンド磁石8は、純水中に浸漬され且つ超音波によって洗浄される。

【0019】最後に、上記ボンド磁石8の表面に対し樹脂被覆(S9)を行う。この樹脂被覆には、例えば電着塗装による膜厚が数10μmのエポキシ系樹脂を被覆する。すると、図4(C)に示すように、Niメッキ層6の表面上に樹脂被覆層7が形成された希土類ボンド磁石9を得ることができる。この希土類ボンド磁石9は、内部に水分やメッキ液が存在せず、且つ全表面が緻密で強固なNiメッキ層6と樹脂被覆層7によって被覆されているため、耐食性、特に耐酸性に優れると共に、強度も高いので外力や熱変化等によって割れや欠け等を生じることとも防止することが可能となる。即ち、前記ボンド磁石8を含む本発明の希土類ボンド磁石(8,9)は、内部の少なくとも表層部が磁石粉末2と樹脂3,5によって緻密な組織であり、且つ外部に少なくとも緻密で強固な金属(Ni)メッキ層6を被覆することで、耐食性と強度の双方を高めたものである。尚、希土類ボンド磁石8,9は追って適宜着磁されて使用される。

【0020】

【実施例】以下において本発明の希土類ボンド磁石の実施例を比較例と共に説明する。先ず、Nd₁₀Fe₇B₃の組成よりなり且つ平均粒径が140μmの希土類磁石粉末(2):100重量部と、エポキシ樹脂(3):10重量部と、ステアリン酸亜鉛:2重量部とを配合してプレスにより、外径20mm、内径18mm、高さ7mmのリング形状に成形(S1)する。このリング状成形体を約140℃に加熱して、上記エポキシ樹脂(3)を硬化(S2)させて、前記希土類磁石素材(1)を1200個得た。これらの磁石素材(1)をバレル研磨し、更に洗浄(S3)した。そのうち600個の磁石素材(1)に対して、アクリル樹脂を用いて前記含浸処理(S4)を行った。上記アクリル樹脂にはポリエチレングリコールジメタクリレート:80%以下、リン酸エステルモノマ:15%以下、その他が有機物からなる加熱硬化型含浸剤を用いた。また、含浸(S4)における減圧工程(S4a)の条件は、前記容器11内の圧力を約10Torrに減圧し且つ30分間保持した。その後、前記容器11内をエアによって約2気圧に10分間保持する加圧工程(S4b)を行った。

【0021】次に、含浸(S4)処理した磁石素材(1)を洗浄(S5)及び硬化(S6)した。その後、この600個

と上記含浸処理(S 4)を施さなかった残りの600個のうちの300個とに対して、ドライエッチングによる表層樹脂の除去(S 7)を行った。これに用いたプラズマエッチングは、3 Torr以下の減圧下で電極間に磁石素材(1)を置いて酸素のプラズマを30分照射するもので、表層面のエポキシ樹脂(3)等が灰化して除去された実施例の磁石素材(1')を900個得た。尚、上記含浸処理(S 4)とドライエッチング(S 7)との双方を施さなかった残りの300個が比較例の磁石素材(1)である。

【0022】更に、実施例の900個の磁石素材(1')と比較例の300個の磁石素材(1)の全てに対し、金属メッキ(S 8)を施した。これに用いたNiメッキは、前記ワット浴とメッキ条件による電解Niメッキであり、そのNiメッキ層6の厚さは平均で約5~35 μ mであり、これを表面に被覆した実施例の希土類ボンド磁石(8)と比較例のボンド磁石をそれぞれ得た。この実施例のボンド磁石(8)のうち、前記含浸処理(S 4)しなかった300個を実施例1とした。また、残り600個の前記含浸処理(S 4)と表層樹脂の除去(S 7)の双方を施した実施例のボンド磁石(8)を2グループに分け、上記Niメッキ(S 8)したままの希土類ボンド磁石(8)の300個を実施例2とした。

【0023】そして、残り300個のボンド素材(8)に対して、更に樹脂被覆(S 9)を施した。これに用いた電着塗装は、エポキシ樹脂+顔料: 20重量部、酸+溶剤: 2重量部、水: 78重量部の溶液を用い、電圧を100Vまで徐々に上昇させることによって上記溶液に気泡が生

じるのを防止しつつ、3~20分間に渉りボンド磁石(8)を処理した。この結果、Niメッキ層6の表面上に厚さ約5~35 μ mのガスピンホールのないエポキシ樹脂からなる電着塗膜7を均一に被覆した実施例3の希土類ボンド磁石(9)が300個得られた。

【0024】以上の各300個ずつの実施例1~3の希土類ボンド磁石(8, 9)と、300個の比較例のボンド磁石について、耐食性と熱変化に対する強度を調査した。耐食性は、ボイリング試験と湿潤試験との双方を行った。ボイリング試験は、100℃の沸騰水中に3時間浸漬して、各ボンド磁石(8, 9)の表面の錆の有無を検査した。また、湿潤試験は、80℃で相対湿度95%の高温・高湿度の雰囲気中に300時間に渉り保持して、上記と同様に錆の有無を検査した。

【0025】更に、熱変化に対する強度は、熱衝撃試験によって測定した。この熱衝撃試験は、ボンド磁石(8, 9)に対し、-20℃×1分間の保持と+80℃×1分間の保持を、交互に200サイクルに渉り繰り返して行い、ボンド磁石(8, 9)の表面に熱応力によって生じる割れや欠けの有無を目視で検査した。以上の各試験に対し、実施例1~3の希土類ボンド磁石(8, 9)、と比較例のボンド磁石をそれぞれ3等分して、100個ずつに分割し、各試験に対し100個ずつを用いて測定した。その結果を表1に示す。

【0026】

【表1】

	ボイリング試験 の発錆個数	湿潤試験 の発錆個数	熱衝撃試験 の欠け割れ個数
実施例1	14	7	0
実施例2	0	0	0
実施例3	0	0	0
比較例	53	48	22
試験内容	100℃×3hr	80℃×95%RH ×300hr	-20℃↔80℃ ×200サイクル
評価方法	10倍顕微鏡で 錆の有無検査	同 左	欠け、割れを 目視で検査

(n = 100)

【0027】表1の結果から、比較例のボンド磁石はボイリングと湿潤試験の双方で約50%のものが発錆した。これに対し、実施例1の希土類ボンド磁石(8)では約10%に発錆が低下し、実施例2のボンド磁石(8)と実施例3のボンド磁石(9)では発錆したものは全くなかった。即ち、比較例のボンド磁石は、前記含浸処理(S 4)と表層樹脂の除去(S 7)の双方が施されていないため、内部の空孔(4)に水分やメッキ液が残留すると共に、表層面におけるNiメッキ層(6)も樹脂バインダ

(3)上に不安定なまま形成されているため、約半分のも

のが錆を生じたものと思われる。

【0028】また、実施例1のボンド磁石(8)は、Niメッキ層(6)が磁石粉末(2)に直に結合して強固且つ緻密に形成されているが、前記含浸処理(S 4)が施されていないため、内部の空孔(4)に水分やメッキ液が残留したことにより、約10%の発錆例を生じたものと思われる。これらに対し、実施例2のボンド磁石(8)と実施例3のボンド磁石(9)は、内部の空孔(4)がアクリル樹脂

(5)で埋められ、且つ表層面の磁石粉末(2)に直に結合したNiメッキ層(6)が強固且つ緻密に形成されているため、全く錆びなかったものと考えられる。尚、海水等の塩基性雰囲気下で使用する場合は、実施例3の希土類ボンド磁石(9)を用いることが望ましい。

【0029】更に、表1の結果から、比較例のボンド磁石は、熱衝撃試験において約20%のものに割れ又は欠けが生じたが、実施例1～3の希土類ボンド磁石(8, 9)では、何れも全く割れ等を来さなかった。これは、実施例1～3のものは表層面の磁石粉末(2)に直にNiメッキ層(6)が形成されているので、この強固で緻密なメッキ層(6)によって、激しい熱変化に対しても内部が保護されたものと考えられる。この熱衝撃試験により、ボンド磁石(8, 9)内の各部分の密着強度が高いことが理解される。従って、実施例1～3の希土類ボンド磁石(8, 9)によれば、熱衝撃等による割れや欠けを防止することが十分に可能である。

【0030】本発明は以上に説明した実施形態や実施例に限定されるものではない。例えば、前記磁石素材1内の空孔4を埋める嫌気性樹脂には、前記アクリル系の他に、ポリエチレン、ポリプロピレン、ポリウレタン等を用いることもできる。また、金属メッキを電解Niメッキに替えて、Cuの電解メッキ、或いはNi基又はCu基合金の電解メッキを使用することも可能である。更に、金属メッキ層の表面上に形成する樹脂被覆層には、前記エポキシ系の他、ポリアミド(ナイロン)、アクリル、又はポリプロピレン等の各種の合成樹脂を用いることができ、且つ均一な塗膜が形成できる浸漬法や電気泳動塗装(被覆)法等を使用することも可能である。尚、本発明の希土類ボンド磁石は、前記リング形状に限らず、外径に

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【0031】

【発明の効果】本発明の希土類ボンド磁石は、その表層面に位置する磁石粉末の表面上に直にNi等の金属メッキ層が形成されているので、従来のものに比べて優れた耐食性と熱変化に対する高い強度を併有することができる。従って、長期的に安定した磁気特性と耐久性とを発揮することが可能になる。また、請求項2の希土類ボンド磁石によれば、上記に加えて、更に一層高く安定した耐食性を保有することができる。更に、本発明の製造方法によれば、内部を緻密な組織にして、上記の優れた耐食性と高強度を有する希土類ボンド磁石を確実に製造することができる。加えて、請求項7の製造方法によれば、更に一層優れた耐食性を有する希土類ボンド磁石を確実に得ることができる。

【図面の簡単な説明】

【図1】本発明の製造方法の各工程を示すフローチャート。

【図2】(A)は本発明に用いる磁石素材の斜視図、(B)及び(C)は共に本発明の製造方法における含浸処理の各工程を示す概略図。

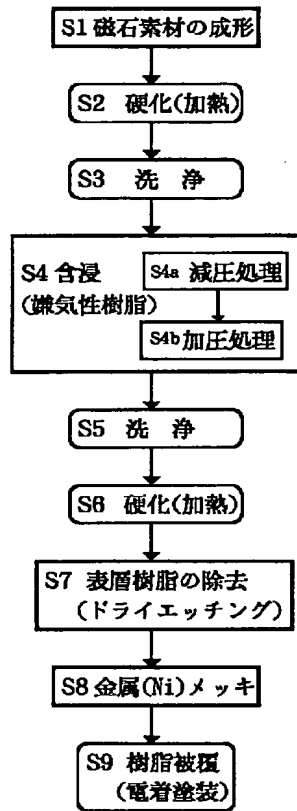
【図3】(A)及び(B)は本発明の希土類ボンド磁石の各製造工程における磁石素材の模式的な拡大断面図。

【図4】(A)乃至(C)は本発明の希土類ボンド磁石等の模式的な拡大断面図。

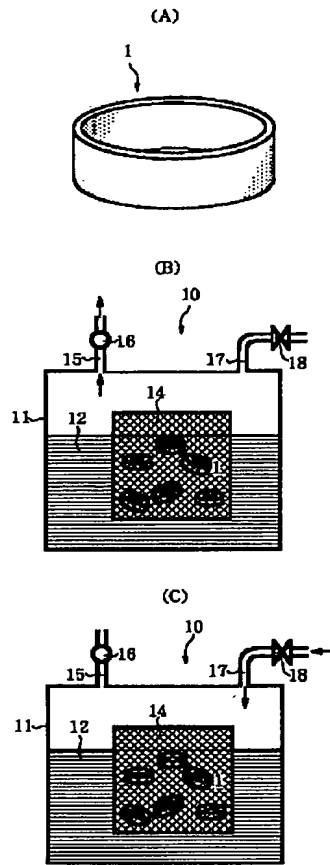
【符号の説明】

- 1, 1' …磁石素材
- 2 ……希土類磁石粉末
- 3 ……エポキシ樹脂(樹脂バインダ)
- 5 ……アクリル樹脂(嫌気性樹脂)
- 6 ……Niメッキ層(金属メッキ層)
- 7 ……樹脂被覆層、
- 8, 9 ……希土類ボンド磁石

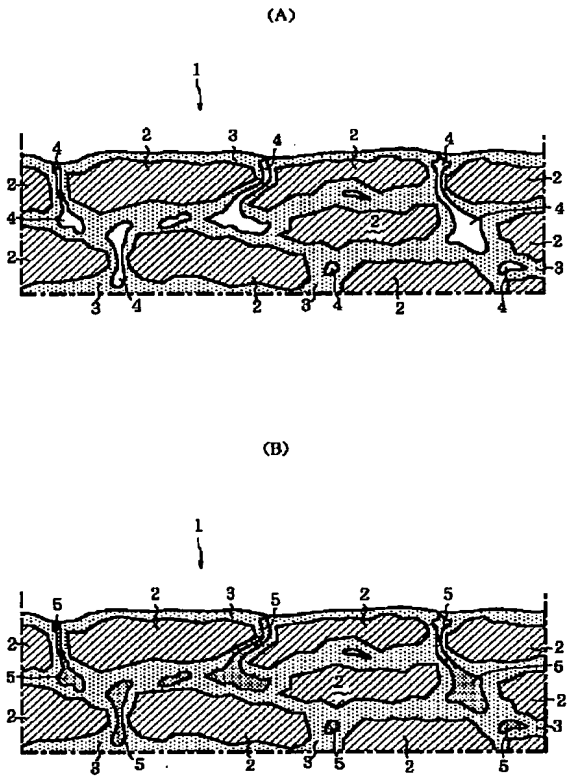
【図 1】



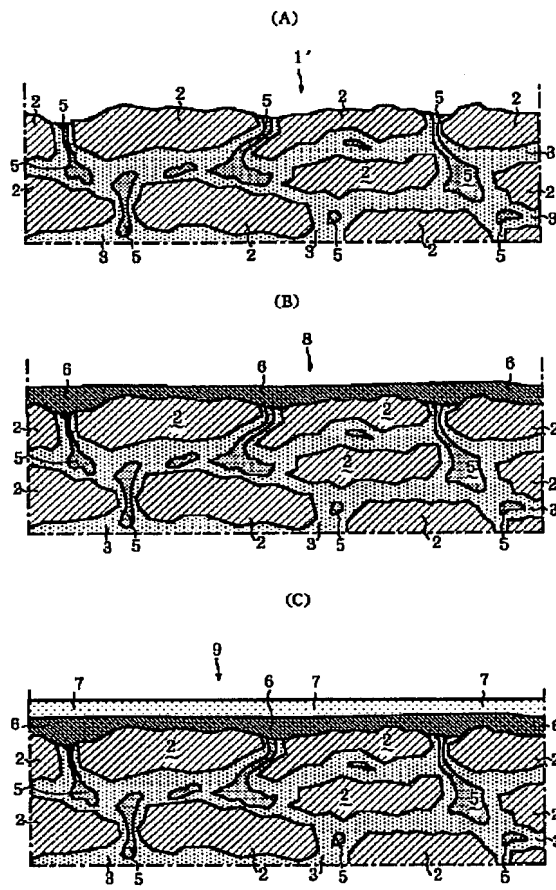
【図 2】



【図 3】



【図 4】



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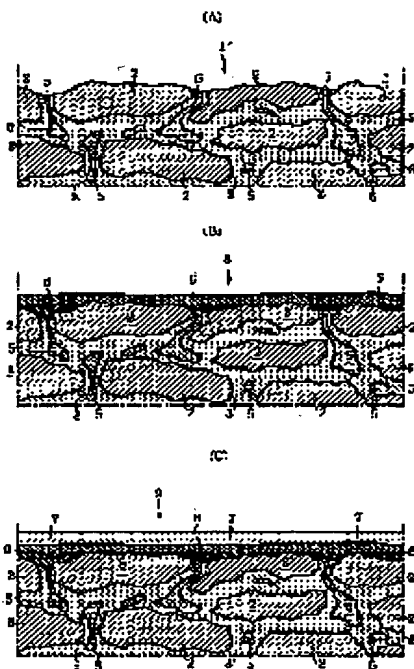
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(54) RARE-EARTH BONDED MAGNET AND ITS MANUFACTURE



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a solid rare-earth bonded magnet which hardly rusts, and hardly cracks or chips due to thermal changes.

SOLUTION: A rare-earth bonded magnet 8 is manufactured by forming a magnet blank by binding rare-earth magnet powder composed of an Nd-Fe-B series alloy with a binder composed of an epoxy resin 3 and a plated Ni-layer 6 directly on the surface of the rare-earth magnet power 2 existing on the surface of the blank. Also included is a rare-earth bonded magnet 9 obtained by forming a resin coating layer 7, made of epoxy

resin on the surface of the plated-Ni layer 6 of the magnet 8. In addition, a method is included for manufacturing the rare-earth bonded magnet 8 by forming the plated-Ni

layer 6 directly on the surface of magnet powder 2, exposed by impregnating the magnet blank with an acrylic resin 5 and removing the epoxy resin 3, etc., coating the external surface of the powder 2 by dry etching, and then plating the magnet powder 2 exposed on the surface of the obtained magnet blank 1' with Ni, and yet another method for manufacturing the rare-earth bonded magnet 9 includes forming the resin coating layer 7 on the surface of the magnet 8.

*** NOTICES ***

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

[Claim(s)]

[Claim 1] The rare earth bond magnet characterized by what the metal deposit is soon formed for on the front face of the above-mentioned magnet powder which is the rare earth bond magnet which combined rare earth magnet powder with the resin binder, and is located in the surface side.

[Claim 2] The rare earth bond magnet characterized by what the resin enveloping layer is further formed for on the front face of this metal deposit while a metal deposit is soon formed on the front face of the above-mentioned magnet powder which is the rare earth bond magnet which combined rare earth magnet powder with the resin binder, and is located in the surface side.

[Claim 3] The rare earth bond magnet according to claim 1 or 2 characterized by what said rare earth magnet powder is Nd-Fe-B system magnet alloy powder by the super-quenching method, and said resin binder is epoxy system resin.

[Claim 4] Claim 1 characterized by what said metal deposit consists of an alloy which uses as the base these any [nickel, Cu(s), or] to be thru/or a rare earth bond magnet given in any of 3.

[Claim 5] A rare earth bond magnet given in claim 1 thru/or any of 4 they are. [which is characterized by what is done for the impregnation of the anaerobic resin, such as acrylic, into said resin binder]

[Claim 6] The manufacture approach of the rare-earth bond magnet characterized by what the process which forms a metal deposit soon on the front face of the above-mentioned magnet powder located in the cleaning process which removes the organic substance, such as a wrap resin binder, and the surface side of this magnet raw material in the surface side of this magnet raw material the process which mixes a resin binder with rare earth magnet powder, and fabricates for the rare earth magnet raw material of a predetermined configuration, the process which sink anaerobic resin into this magnet raw material, and after that includes for.

[Claim 7] The manufacture approach of the rare earth bond magnet characterized by

what it has for the process which forms a resin enveloping layer on the front face of this metal deposit further after the process which forms said metal deposit while including said each process in claim 6.

[Claim 8] The manufacture approach of the rare earth bond magnet according to claim 6 or 7 characterized by what said anaerobic resin is resin, such as acrylic.

[Claim 9] The manufacture approach of a rare earth bond magnet given in claim 6 thru/or any of 8 they are. [which is characterized by what the cleaning process which removes the organic substance, such as a wrap resin binder, is performed for by dry etching, such as plasma etching, reactive ion etching, ion beam etching, reactant ion beam etching, or reactant vapor etching, in the surface of said magnet raw material]

[Claim 10] The manufacture approach of a rare earth bond magnet given in claim 6 thru/or any of 9 they are. [which is characterized by what the process which forms said metal deposit is nickel plating performed using a Watts bath or a sulfamic acid bath]

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the rare earth bond magnet used in the extensive applications the object for motors, for magnetometric sensors, etc., and its manufacture approach.

[0002]

[Description of the Prior Art] general -- a rare earth bond magnet -- rare earth magnet powder -- receiving -- several -- wt% -- after mixing-every a resin binder, a shaping assistant, etc., it fabricates with a press etc. in a predetermined configuration, and is manufactured by heating further and stiffening the above-mentioned resin binder. Moreover, the above-mentioned rare earth magnet powder has the property which it oxidizes and is easy to carry out rusting, and also including a resin binder, since it is weak, it tends to produce a crack and a chip by the time of assembly, etc. and the thermal change. In order to prevent these, the resin layer by electropainting etc. is further covered by the magnetic front face.

[0003] By the way, when the motor incorporating the above-mentioned rare earth bond magnet etc. is used in the environment of the ambient atmosphere containing the salt water near the seashore, or a remarkable temperature gradient, rust, a crack, etc. may be produced on the front face of a rare earth bond magnet. For this reason, changing to the resin coat by electropainting etc. and forming a precise metal deposit in the front face of a bond magnet is also considered. However, since the resin coat used as a binder

is formed, the problem of acting as an electric nonconductor in case this resin coat performs this metal plating, or forming a pinhole according to a block operation of film formation is shown in the front face of the rare earth bond magnet which carried out heat curing.

[0004] Furthermore, a hole may be formed between the magnet powder in the rare earth bond magnet which carried out heat curing, and into a resin binder. In this hole, if immersed during a plating bath the time of washing for example, a bond magnet, and for the above-mentioned metal plating, moisture and plating liquid will remain. This residual moisture etc. had the problem of it having been open for free passage at a certain opportunity with the open air, having oxidized surrounding magnet powder at it, and inviting rusting to it, when the rare earth bond magnet in which a resin enveloping layer or metal plating was formed on the front face was used for years as **.

[0005]

[Problem(s) to be Solved by the Invention] the trouble of the above Prior art [this invention] -- solving -- rust -- hard -- and let it be a technical problem to offer the manufacture approach of the rare earth bond magnet of the high intensity which cannot produce the crack or chip by the thermal change easily, and the rare earth bond magnet suitable for manufacturing this.

[0006]

[Means for Solving the Problem] This invention is hit on an idea of it and accomplished to form a metal deposit soon on the front face of the magnet powder in the surface side of a rare earth bond magnet. That is, the rare earth bond magnet of this invention is a rare earth bond magnet which combined rare earth magnet powder with the resin binder, and is characterized by what the metal deposit is soon formed for on the front face of the above-mentioned magnet powder located in the surface side. Since a precise and firm metal deposit serves as a rare earth bond magnet formed in the front face according to this, it has the reinforcement which cannot produce easily the crack or chip by the corrosion resistance and the thermal change which were rust-hard and were excellent, and the magnetic properties stabilized in the long run can be made to demonstrate.

[0007] In addition, in this invention, a magnet is called including the thing before being magnetized. Moreover, another rare earth bond magnet of this invention is a rare earth bond magnet which combined rare earth magnet powder with the resin binder, and it is characterized by what the resin enveloping layer is further formed for on the front face of this metal deposit while a metal deposit is soon formed on the front face of the above-mentioned magnet powder located in the surface side. According to this, the rare

earth bond magnet which was further further excellent in corrosion resistance in addition to the above can be offered.

[0008] Furthermore, said rare earth magnet powder is Nd-Fe-B system magnet alloy powder obtained by the super-quenching method, and the rare earth bond magnet said whose resin binder is epoxy system resin is also included. Thereby, magnetic properties, such as a high magnetic energy product, the outstanding corrosion resistance, and high intensity can be made to hold. In addition, as a permutation element of Nd, one sort of rare earth elements, such as Pr, La, Ce, Sm, and Mm, or two sorts or more are used, and as a permutation element of Fe, Co, nickel, Mn, Cu, etc. are used and Si, P, C, N, etc. are further used suitably as a permutation element of B.

[0009] Moreover, the rare earth bond magnet with which said metal deposit consists of an alloy which uses as the base these any [nickel, Cu(s), or] to be is also contained. According to this, since the front face is covered with metal deposits, such as precise and firm nickel, it becomes the stable rare earth bond magnet which is high intensity and was excellent in rust-proofing nature. Furthermore, the rare earth bond magnet with which impregnation of the anaerobic resin, such as acrylic, is carried out is also contained in said resin binder again. This becomes the internal rare earth bond magnet which there is no hole in the surface section at least, and covered metal deposits, such as nickel, firmly on the front face.

[00010] On the other hand, the manufacture approach of the rare earth bond magnet of this invention The process which mixes a resin binder with rare earth magnet powder, and is fabricated for the rare earth magnet raw material of a predetermined configuration, It is characterized by what the process which forms a metal deposit soon on the front face of the above-mentioned magnet powder located in the cleaning process which removes the organic substance, such as a wrap resin binder, and the surface side of this magnet raw material in the surface side of this magnet raw material the process which sinks anaerobic resin into this magnet raw material, and after that is included for. The rare earth bond magnet which has the metal deposit which considered the surface section as the precise organization without a hole at least by this, and was coupled directly with magnet powder on the front face can be offered certainly. In addition, as for the process which sinks in the above-mentioned anaerobic resin, it is desirable to carry out by pressurizing, after carrying out under reduced pressure or decompressing.

[0011] Moreover, while including said each process in said manufacture approach, the manufacture approach of a rare earth bond magnet of having the process which forms a resin enveloping layer on the front face of this metal deposit further after the process which forms said metal deposit is also included. Thereby, the rare earth bond magnet

which was further excellent in corrosion resistance in addition to the above can be offered. Furthermore, said anaerobic resin also includes the manufacture approach of the rare earth bond magnet which are resin, such as acrylic. Thereby, while filling an internal hole, a metal deposit firm as a condition which does not have a pitch in the front face of the magnet powder of a surface side can be formed.

[0012] Moreover, the manufacture approach of a rare earth bond magnet that the cleaning process which removes the organic substance, such as a wrap resin binder, is performed by dry etching, such as plasma etching, reactive ion etching, ion beam etching, reactant ion beam etching, or reactant vapor etching, is also included in the surface of said magnet raw material. Since the front face of the magnet powder of a surface side may be exposed certainly, a metal deposit can be made to form in the front face of a bond magnet certainly according to this. In addition, ozone cleaning, ultraviolet-rays cleaning, corona discharge cleaning, etc. are included in the above-mentioned cleaning process other than the above. In addition, the manufacture approach of a rare earth bond magnet that the process which forms said metal deposit is nickel plating performed using a Watts bath or a sulfamic acid bath is also included. Thereby, healthy nickel deposit can be formed in the front face of a bond magnet.

[0013]

[Embodiment of the Invention] The suitable gestalt for operation of this invention is explained with a drawing below. Drawing 1 shows the flow chart of the manufacture approach of the rare earth bond magnet of this invention. First, the flat rare earth magnet powder which has the presentation of Nd₁₆Fe₇₇B₇ with a super-quenching method is manufactured. This magnet powder is abbreviation die length of 100-200 micrometers, thickness 10 - 10 micrometers of numbers, and an aspect ratio (ratio of die length or width of face, and thickness) is the thing of 5-10 within the limits. This rare-earth-magnet powder: To the 100 weight sections, blend the epoxy system resin:10 weight section and the zinc stearate:2 weight section as a shaping assistant, and fabricate them using the press by the die and punch which are not illustrated in the outer diameter of 20mm, the bore of 18mm, and a ring configuration with a height of 7mm (S1). If this ring-like Plastic solid is heated at about 140 degrees C and the binder slack above-mentioned epoxy system resin is stiffened (S2), it will become the rare earth magnet raw material 1 shown in drawing 2 (A).

[0014] Next, this rare earth magnet raw material 1 is put into a barrel, a front face is ground, the weld flash at the time of shaping etc. is removed, it is further immersed into pure water, a supersonic wave is given, and the front face of the magnet raw material 1 is washed (S3). Furthermore, impregnation (S4) of anaerobic acrylic resin is performed

by the reduced pressure lower etc. to the rare earth magnet raw material 1 after washing. The above-mentioned magnet raw material 1 is the porous organization in which many holes 4 exist in random between the magnet powder 2 and 2 [the inside of this resin 3, or], although the rare earth magnet powder 2 of flat a large number is combined with epoxy system resin 3 as typically shown in drawing 3 (A). Moreover, the exterior is opening some holes 4 for free passage. It is the object of this impregnation process (S4) to fill this hole 4 and to make it a precise organization. As shown in drawing 2 (B), anaerobic resin liquid 12, such as an acrylic, is beforehand put in in the impregnation processor 10 which consists of a pressurized container 11. First, the basket 14 which put in two or more magnet raw materials 1 is immersed into the above-mentioned resin liquid 12. With the exhaust pipe 15 at the upper left of a container 11 to the pump 16, the air in a container 11 is discharged and the inside of a container 11 is decompressed even near the abbreviation vacuum (S4a). Under the present circumstances, the feed pipe 17 at the upper right of a container 11 is closed by that valve 18. Consequently, since the pressure in a container 11 is decompressed to Number Torr - number 10Torr extent, the above-mentioned resin liquid 12 sinks in compulsorily into each hole 4 in the magnet raw material 1.

[0015] After predetermined time passes and impregnation (S4a) of the resin liquid 12 is carried out into each hole 4 in the magnet raw material 1, as shown in drawing 2 (C), an exhaust pipe 15 is closed by the valve which does not suspend and illustrate the pump 16 of the above-mentioned exhaust pipe 15. Simultaneously, air is compulsorily put in for the above-mentioned valve 18 in a container 11 through the aperture feed pipe 17, and the inside of a container 11 is pressurized at number atmospheric-pressure extent (S4b). By this, impregnation of the above-mentioned resin liquid 12 can be carried out more than enough into each hole 4 in the magnet raw material 1. Next, the magnet raw material 1 is immersed into ejection and pure water, a supersonic wave is given, the front face of the magnet raw material 1 is washed (S5), and the anaerobic resin 12 adhering to the front face of the magnet raw material 1 is removed. Under the present circumstances, the above-mentioned resin 12 is easily removed for an anaerobiosis. Furthermore, it heats to predetermined temperature and the anaerobic resin 12 in a hole 4 is stiffened (S6). Consequently, as shown in drawing 3 (B), the above-mentioned resin 12 changes the organization in the magnet raw material 1 into a precise condition while turning into the acrylic resin 5 hardened in the location of each hole 4. In addition, the above-mentioned resin 12 (5) does not remain in the surface side of the magnet raw material 1, as shown in drawing 3 (B).

[0016] Subsequently, to this magnet raw material 1, dry etching is performed and wrap

epoxy system resin 3 grade is removed for that surface side (S7). Plasma etching is used as the above-mentioned dry etching. This plasma etching generates the plasma of oxygen in homogeneity in inter-electrode [of two sheets] in the reduced pressure condition below Number Torr, places the magnet raw material 1 into this plasma, and ashes the organic substance which is [that surface side] mainly concerned with wrap epoxy system resin 3. Consequently, as shown in drawing 4 (A), magnet raw material 1' which the lateral surface of each magnet powder 2 located in a surface side exposes is obtained. Under the present circumstances, since said acrylic resin 5 has not covered in the surface side of magnet raw material 1', the conductivity of this raw material 1' becomes good.

[0017] Furthermore, metal (nickel) plating (S8) is performed to this magnet raw material 1'. This nickel plating is immersed considering anode plate and magnet raw material 1' as cathode in nickel for example, into a Watts bath, and applies an electrical potential difference between two electrodes. And nickel of a soluble anode is dissolved, and it puts in during a bath as a metal ion, and the front face of magnet raw material 1' by the side of cathode is deposited. Electrolysis nickel plating of the plating conditions for bath temperature:55 degree C, bath pH:5.6, electrical-potential-difference:7V, and processing-time:10 minutes is performed in the above-mentioned Watts bath, using nickel-sulfate:280g/l., nickel chloride:20g/l., boric-acid:20g/l., and brightener:small quantity.

[0018] On the occasion of this nickel plating, the lateral surface which each magnet powder 2 located in the surface side of magnet raw material 1' exposes acts as cathode. For this reason, as shown in drawing 4 (B), the rare earth bond magnet 8 which covered the precise and firm nickel deposit 6 can be obtained. Moreover, since said hole 4 is filled with acrylic resin 5, the above-mentioned plating liquid does not advance into the interior of the bond magnet 9. Therefore, it can be used as a rare earth bond magnet excellent in corrosion resistance by magnetizing suitably also with this bond magnet 8. In addition, plating conditions can be changed, starting nickel plating process can be divided into two steps, a semigloss nickel deposit can be formed at first, and a gloss nickel deposit can also be further formed in the top face. Moreover, after nickel plating is carried out [above-mentioned], it is immersed into pure water and the bond magnet 8 is washed by the supersonic wave.

[0019] Finally, a resin coat (S9) is performed to the front face of the above-mentioned bond magnet 8. In this resin coat, the thickness by electropainting covers the epoxy system resin which is several 10 micrometers. Then, as shown in drawing 4 (C), the rare earth bond magnet 9 with which the resin enveloping layer 7 was formed on the front

face of the nickel deposit 6 can be obtained. Neither moisture nor plating liquid exists in the interior, and since this rare earth bond magnet 9 is covered with the nickel deposit 6 precise [all front faces] and firm and the resin enveloping layer 7, it becomes possible [corrosion resistance and that producing a crack, a chip, etc. by external force, a thermal change, etc. since reinforcement is also high while excelling especially in acid resistance also prevents]. That is, at least, the surface section is being a precise organization and covering the internal metal (nickel) deposit 6 outside precise at least and firm with the magnet powder 2 and resin 3 and 5, and the rare earth bond magnet (8 9) of this invention containing said bond magnet 8 raises the both sides of corrosion resistance and reinforcement. In addition, the rare earth bond magnets 8 and 9 are used later on, magnetizing them suitably.

[0020]

[Example] The example of the rare earth bond magnet of this invention is explained with the example of a comparison below. First, it consists of a presentation of Nd₁₆Fe₇₇B₇, and the rare earth magnet powder (2):100 weight section whose mean particle diameter is 140 micrometers, the epoxy resin (3):10 weight section, and the zinc stearate:2 weight section are blended, and it fabricates with a press in the outer diameter of 20mm, the bore of 18mm, and a ring configuration with a height of 7mm (S1). This ring-like Plastic solid was heated at about 140 degrees C, the above-mentioned epoxy resin (3) was stiffened (S2), and said 1200 rare earth magnet raw materials (1) were obtained. Barrel finishing of these magnet raw materials (1) was carried out, and they were washed further (S3). It magnet raw materials [600] (1) Received among those, and said impregnation processing (S4) was performed using acrylic resin. the above-mentioned acrylic resin -- polyethylene-glycol-dimethacrylate; -- less than [phosphoric ester monomer;15%] and others used the heat hardening mold impregnant which consists of the organic substance 80% or less. Moreover, the conditions of the reduced pressure process (S4a) in impregnation (S4) decompressed the pressure in said container 11 to about 10 Torr(s), and held it for 30 minutes. Then, the application-of-pressure process (S4b) which holds the inside of said container 11 for 10 minutes in about 2 atmospheric pressures by air was performed.

[0021] Next, the magnet raw material (1) which carried out impregnation (S4) processing was washed and (S5) hardened (S6). Then, the surface resin by dry etching was removed to these 600 pieces and 300 of 600 pieces of the remainder which did not perform the above-mentioned impregnation processing (S4) (S7). Plasma etching used for this put the magnet raw material (1) on inter-electrode under reduced pressure of 3 or less Torrs, irradiates the plasma of oxygen for 30 minutes, and obtained 900 magnet

raw materials (1') of an example from which the epoxy resin (3) of a surface side etc. ashed, and was removed. In addition, the 300 remaining pieces which did not give the both sides of the above-mentioned impregnation processing (S4) and DORAIMA etching (S7) are the magnet raw materials (1) of the example of a comparison.

[0022] Furthermore, metal plating (S8) was performed to 900 magnet raw materials (1') of an example, and all the 300 magnet raw materials (1) of the example of a comparison. nickel plating used for this was electrolysis nickel plating by said Watts bath and plating conditions, and the thickness of the nickel deposit 6 is about 5-35 micrometers on an average, and obtained the rare earth bond magnet (8) of an example and the bond magnet of the example of a comparison which covered this on the front face, respectively. 300 pieces which did not carry out said impregnation processing (S4) among the bond magnets (8) of this example were made into the example 1. Moreover, the bond magnet (8) of the example which gave the both sides of clearance (S7) of said remaining 600 impregnation processings (S4) and surface resin was divided into two groups, and 300 of a rare earth [above-mentioned having carried out nickel plating (S8)] bond magnet (8) were made into the example 2.

[0023] And the resin coat (S9) was further given to remaining 300 bond raw materials (8). The electropainting used for this processed the **** bond magnet (8) in 3 - 20 minutes, preventing that air bubbles arise in the above-mentioned solution by raising an electrical potential difference gradually to 100V using the solution of the epoxy resin + pigment:20 weight section, the acid + solvent:2 weight section, and the water:78 weight section. Consequently, 300 rare earth bond magnets (9) of the example 3 which covered to homogeneity electrodeposited **** 7 which consists of an epoxy resin which does not have a gas pinhole with a thickness of about 5-35 micrometers on the front face of the nickel deposit 6 were obtained.

[0024] Corrosion resistance and the reinforcement to a thermal change were investigated about the rare earth bond magnet (8 9) of every above 300 examples 1-3 each, and the bond magnet of 300 examples of a comparison. Corrosion resistance performed the both sides of a boiling trial and a humidity cabinet test. The boiling trial was immersed in 100-degree C ebullition underwater for 3 hours, and inspected the existence of the rust of the front face of each bond magnet (8 9). Moreover, **** maintenance was carried out at 80 degrees C in 300 hours into the ambient atmosphere of an elevated temperature and high humidity of 95% of relative humidity, and the humidity cabinet test inspected the existence of rust like the above.

[0025] Furthermore, the reinforcement to a thermal change was measured by the spalling test. This spalling test inspected visually the existence of the crack which

produces the maintenance for [-20 degree-Cx] 1 minute, and the maintenance for [+80 degree-Cx] 1 minute with thermal stress on the front face of **** repeat ***** and a bond magnet (8 9) in 200 cycles by turns, or a chip to the bond magnet (8 9). To each above trial, the rare earth bond magnet (8 9) of examples 1-3 and the bond magnet of the example of a comparison were equally divided into three, respectively, and it divided into 100 pieces at a time, and measured using every 100 pieces to each trial. The result is shown in a table 1.

[0026]

[A table 1]

	ボイリング試験 の発錆個数	湿潤試験 の発錆個数	熱衝撃試験 の欠け割れ個数
実施例 1	14	7	0
実施例 2	0	0	0
実施例 3	0	0	0
比較例	53	48	22
試験内容	100℃×3hr	80℃×95%RH ×300hr	-20℃↔80℃ ×200サイクル
評価方法	10倍顕微鏡で 錆の有無検査	同 左	欠け、割れを 目視で検査

(n = 100)

[0027] From the result of a table 1, about 50% of thing carried out rusting of the bond magnet of the example of a comparison to boiling on the both sides of a humidity cabinet test. On the other hand, there was nothing that rusting fell to about 10% with the rare earth bond magnet (8) of an example 1, and carried out rusting with the bond magnet (8) of an example 2 and the bond magnet (9) of an example 3. That is, since [whose nickel deposit (6) in a surface side is instability on a resin binder (3)] it is often formed, the bond magnet of the example of a comparison is considered that the thing of abbreviation one half produced rust while moisture and plating liquid remain to an internal hole (4), since the both sides of clearance (S7) of said impregnation processing (S4) and surface resin are not given.

[0028] Moreover, it is thought that the bond magnet (8) of an example 1 produced about

10% of example of rusting when moisture and plating liquid remained to the internal hole (4) since said impregnation processing (S4) was not performed although nickel deposit (6) combined with magnet powder (2) soon and was formed firmly and precisely. It is thought that the bond magnet (8) of an example 2 and the bond magnet (9) of an example 3 did not rust at all since nickel deposit (6) which the internal hole (4) was filled with acrylic resin (5) to these, and was soon combined with the magnet powder (2) of a surface side was formed firmly and precisely. In addition, when using it under basic ambient atmospheres, such as seawater, it is desirable to use the rare earth bond magnet (9) of an example 3.

[0029] Furthermore, although the crack or the chip produced the bond magnet of the example of a comparison from the result of a table 1 in about 20% of thing in the spalling test, with the rare earth bond magnet (8 9) of examples 1-3, neither caused the crack etc. at all. Soon, since nickel deposit (6) is formed in the magnet powder (2) of a surface side, as for this, the interior is considered to have been protected by it also to an intense thermal change by this firm and precise deposit (6), as for the thing of examples 1-3. By this spalling test, it is understood that the adhesion reinforcement of each part in a bond magnet (8 9) is high. Therefore, according to the rare earth bond magnet (8 9) of examples 1-3, it is fully possible to prevent the crack and chip by a thermal shock etc.

[0030] This invention is not limited to the operation gestalt or example which were explained above. For example, polyethylene, polypropylene, polyurethane, etc. can also be used for the anaerobic resin which fills the hole 4 in said magnet raw material 1 besides said acrylic. Moreover, it is also possible to change metal plating to electrolysis nickel plating, and to use the electrolytic plating of the electrolytic plating of Cu, nickel radical, or Cu radical alloy. furthermore, the dip coating which can use various kinds of synthetic resin, such as a polyamide (nylon) besides said epoxy system, an acrylic, or polypropylene, for the resin enveloping layer formed on the front face of a metal deposit, and can form a uniform paint film in it and electrophoretic deposition (coat) -- it is also possible to use law etc. in addition, the rare earth bond magnet of this invention was fabricated not only to said ring configuration but to the outer diameter in the cylindrical shape with large height, the shape of a linear cylinder and a rectangular parallelepiped, the shape of horseshoe shape, a radii configuration, etc. -- it is contained.

[0031]

[Effect of the Invention] Since metal deposits, such as nickel, are soon formed on the front face of the magnet powder located in the surface side, the rare earth bond magnet of this invention can have simulataneously the high reinforcement to the corrosion resistance and the thermal change which were excellent compared with the

conventional thing. Therefore, it becomes possible to demonstrate the magnetic properties stabilized in the long run and endurance. Moreover, according to the rare earth bond magnet of claim 2, in addition to the above, the corrosion resistance stabilized further still more highly can be held. Furthermore, according to the manufacture approach of this invention, the interior is made a precise organization, it is certain and the rare earth bond magnet which has the corrosion resistance which was excellent in the above, and high intensity can be manufactured to accuracy. In addition, according to the manufacture approach of claim 7, the rare earth bond magnet which has the corrosion resistance excellent further further can be obtained certainly.

[Brief Description of the Drawings]

[Drawing 1] The flow chart which shows each process of the manufacture approach of this invention.

[Drawing 2] For (A), both the perspective view of the magnet material used for this invention, (B) and, and (C) are the schematic diagram showing each process of the sinking-in processing in the manufacture approach of this invention.

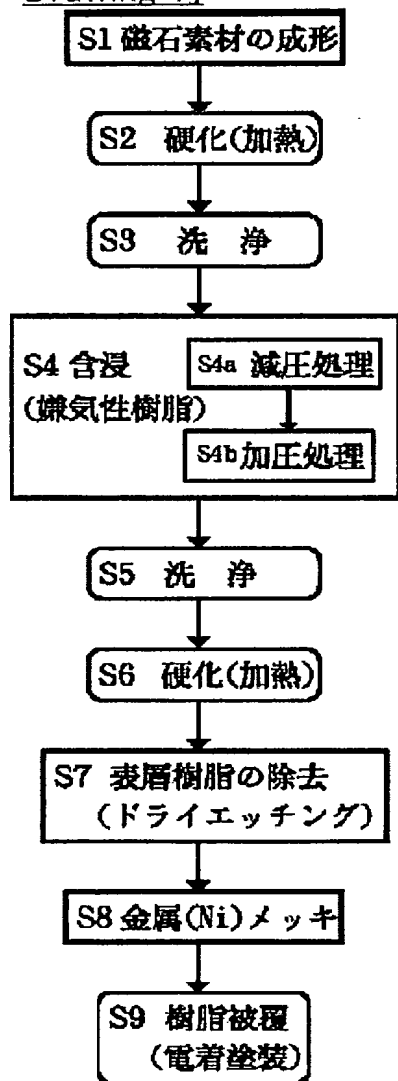
[Drawing 3] (A) And (B) is the typical expanded sectional view of the magnet material in each production process of the rare earth bond magnet of this invention.

[Drawing 4] (A) Or (C) is typical expanded sectional views, such as a rare earth bond magnet of this invention.

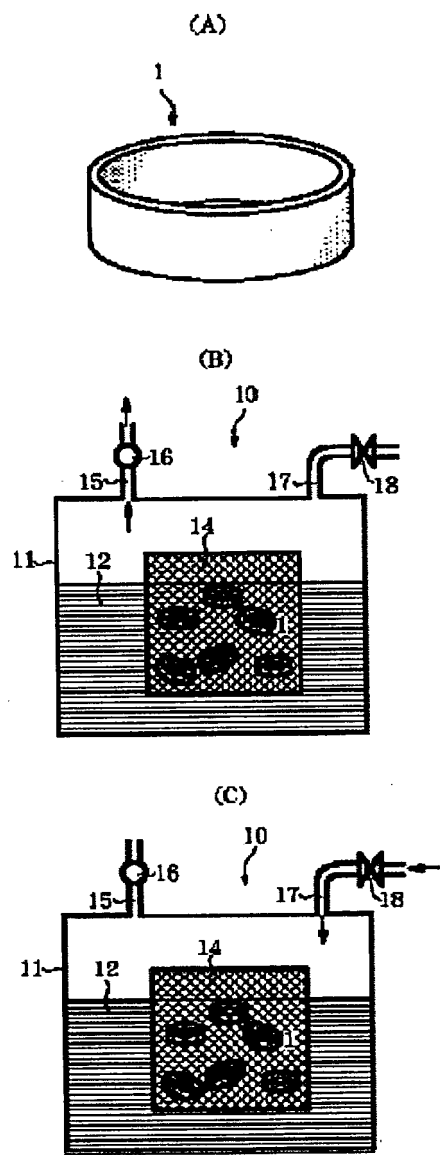
[Description of Notations]

- 1 1' -- Magnet material
- 2 Rare earth magnet powder
- 3 Epoxy resin (resin binder)
- 5 Acrylic resin (anaerobic resin)
- 6 nickel deposit (metal deposit)
- 7 Resin enveloping layer,
- 8 9 Rare earth bond magnet

Drawing 1]

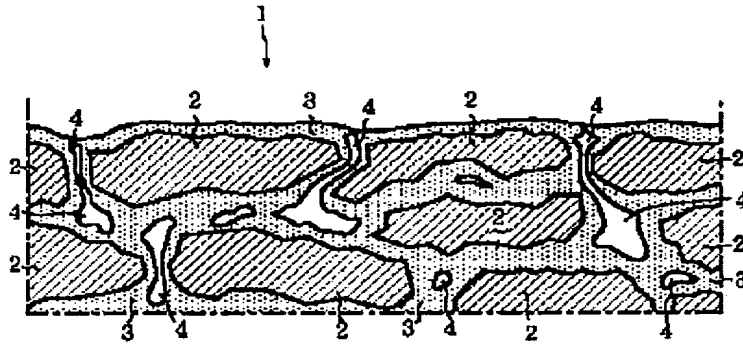


Drawing 2]

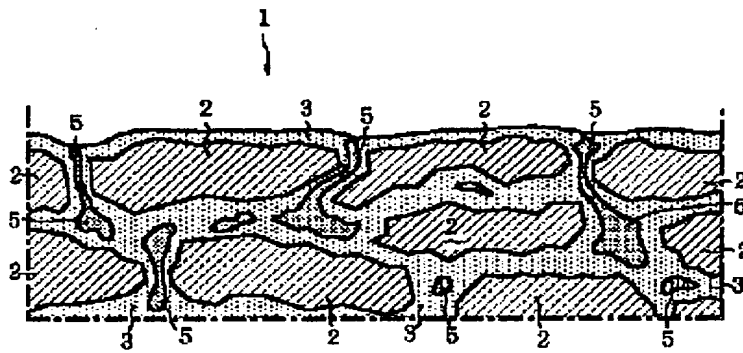


Drawing 3]

(A)



(B)



Drawing 4]

